# WHEN SPEED COUNTS, OPEN INNOVATION MATTERS

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## ABSTRACT

The importance of a firm's collaborations on its performance is well recognized by open innovation literature. However, not all collaborations are equal. Adding to extant research on the breadth and depth of external sources of knowledge, this paper distinguishes among two types of collaborations, namely innovation-oriented and operational-oriented collaborations, on the basis of their scope and looks at their impact on reducing time-to-market, as an indicator of the firm's performance. In doing it, it also considers the moderating role of two organizational capabilities, namely managerial capabilities and internationalization capability. A hierarchical multiple and moderated hierarchical multiple regressions are developed based on a composite dataset of 151 Tuscan (Italy) firms in the life science sector. The results show that a U-shaped relationship characterizes the impact of both collaborations on firm's time-to-market, but also that this link is moderated by managerial and internationalization capabilities.

**Keywords**: *collaborations; managerial capabilities, internationalization capability; time-to-market; Life Sciences*

## 1. INTRODUCTION

This paper focuses on the role of open innovation (OI) in the life science (LS) sector, looking at the moderating impact of core competences on the collaboration-innovation performance link. The importance of collaborations is central to the OI research (Gesing et al. 2015). OI, in fact, requires firms to systematically perform "*knowledge exploration, retention, and exploitation inside and outside an organization's boundaries through the innovation process*" (Lichtenthaler 2011: 77), thus requiring firms to look beyond their boundaries searching for partners to involve in their innovation and commercialization processes. Empirical evidence, however, shows that collaborations may have ambiguous and contradictory effects on the several facets of organizational performance. Among the reasons of such ambiguities and beyond industry characteristics, previous studies have distinguished among two broad categories of factors that may explain heterogeneous results. On the one hand, there

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are *firm-related factors*, such as the stages of product development, the firm's size (Rothaermel and Deeds 2004), and, in particular, the firm's capabilities (Caner & Tyler, 2014; Ferreras-Méndez et al., 2015; Lee et al., 2001; Mitrega et al. , 2012), such as absorptive capacity (Laursen and Salter 2006). On the other hand, we can distinguish *collaboration-related factors*. Most of OI scholars' attention has been deserved to the breadth and the depth of collaborations (Laursen and Salter 2006; Verbano et al., 2015), and in particular, more recent debate is about the effect collaboration partner types have on the payoff from the collaboration (Bengtsson et al. 2015, Gesing et al., 2015). However, little attention has been deserved to the heterogeneity of collaborations a firm deals with (Kim & Lui, 2015; Knudsen, 2007; Laursen and Salter, 2006; Vereecke & Muylle, 2006). Companies, in fact, may collaborate for several reasons, but previous studies have only analysed how the nature of the partners, whether scientific- or market-focused innovation partners (Gesing et al., 2015), contribute to innovation performance, thus overlooking at how different scope of collaborations affect its performance.

This study investigates the impact of the interaction between firm-related and collaboration-related factors on time-to-market (T2M), chosen as a crucial performance indicator in the LS sector. Albeit it is rather intuitive that firms with different capabilities are able to manage different types of collaborations, previous research has mainly focused on relational or networking capabilities as the capabilities needed to engage with partners. Nonetheless, firms possess other capabilities that may be important for exploiting the value of external collaborations. In particular, the outcome from the collaboration may rest upon a firm's capabilities in managing the type of collaborations.

This paper aims to complement extant research via a twofold contribution. A first contribution refers to the distinction between the scope of the network: based on the relational view of the firm, we distinguish between firms that collaborate for innovation-oriented (Caner & Tyler 2014) or operational-oriented (Aarikka-Stenroos et al., 2014) scopes. Second, moving from the resource-based view of the firm, this paper extends previous research by introducing two new capabilities that may moderate the collaboration scope-performance link. In particular, we investigate whether firms possessing managerial and internationalization capabilities (Cruz-Ros & Gonzalez-Cruz, 2015; Fitjar et al. 2013; Wang et al. 2015) are better able to realize the inherent benefits of innovation-oriented and operational-oriented collaborations.

In doing that, we test hypotheses on data collected from an original and unique database based on 151 Tuscan (Italy) organizations operating in the LSs sector, a high-technology-intensive sector (De Luca and Verona and Vicari, 2010), that is characterized by a strong role of collaborations among firms. In particular, we look at the impact of capabilities and type of collaborations on an under-researched new product development performance measure, i.e. the time to market (Tatikonda and Montoya-Weiss 2001). Having a short time to market is an important factor in determining competitive

advantage, in particular in industries where R&D is long and complex (Rothaermel and Deeds 2004; Shan, Walker, and Kogut 1994). Results from the regression model adopted contribute to both, theory and practice. Drawing upon the notion of collaboration, we offer empirical evidence on how to decrease the T2M through combining different types of collaborations and capabilities.

The paper is structured as follows. In the next section we review the literature on collaborations and capabilities and propose a theoretical model with four main research hypotheses. In Section 3, data collection and measurement development are described. The analysis and results are presented in Section 4. Section 5 discusses the results. Finally, concluding remarks which include both theoretical and managerial implications, as well as limitations and future research, are provided.

## 2. THE HETEROGENEITY OF OPEN INNOVATION COLLABORATIONS

*2.1 Effects of collaborations on firms' performance*

OI scholars have often looked at collaborations between firms as a key determinant of firm's performance. Firms often collaborate with third parties to get access to the resources they need. In doing that, firms choose among different types of partners (Bengtsson et al., 2015; Kim & Lui, 2015; Laursen & Salter, 2006; Lopez-Vega et al. 2015).

When looking at collaborations, OI scholars have mainly looked at two measures: the breadth and the depth of relationships (Egbetokun 2015; Laursen & Salter, 2005). Collaborations may happen with a variety of actors such as suppliers, customers, competitors, private laboratories, universities and public research institutes (Egbetokun 2015; Fitjar et al. 2013; Laursen & Salter 2006). How the combination of relationships impacts the performance of the firms depends on the type of industry (Knudsen, 2007; Vereecke & Muylle, 2006) and are usually characterized by an inverted U-shaped relationship with respect to innovation performance. Firms, in fact, may benefit from collaborations up to a certain level since collaborations affect knowledge sharing, complementarity, the emergence of scale economies, knowledge spill-overs and information access as well as risk sharing and access to resources and markets (Pittaway, Robertson, Munir, & Denyer 2004; Pucci and Zanni, 2016), but this effect turns to be negative since collaborating implies costs that cause non-linear relationships on partners- innovation performance link (Laursen and Salter 2006; Bengtsson et al. 2015).

Little attention, however, has been given to the *scope* collaborations are settled up (Rothaermel and Deeds 2004; 2006). Albeit it is tacitly intuitive that the reasons collaborations are made rely on either (or both) the generation and the diffusion of innovation (Nooteboom, 1999; 2000; Rothaermel & Deeds, 2004), literature does not usually distinguish between different collaborations on the basis of their scope. However, academic community often refers to either *innovation-oriented collaborations*, aimed at introducing radical or incremental product or service innovations (Laursen and Salter 2006; Caner and

Tyler 2014), and *operational-oriented collaborations* (Aarikka-Stenroos and Lehtimäki 2014), aimed at enhancing manufacturing, distribution and commercialization/marketing (Caner and Tyler 2014; Rothaermel and Deeds 2004; Wang et al. 2015). We define innovation-oriented collaborations as those collaborations aimed at enhancing the innovativeness and the development of new products and acquiring new knowledge from external partners, while operational-oriented collaborations as those collaborations aimed at acquiring market power, sharing risks, entering in new markets. We want to look at whether these two kinds of collaborations have a different influence on a firm's performance.
Considering extant research on external search breadth and depth (Laursen and Salter, 2006), we make a further step in OI research via distinguishing among the scope (innovation–oriented vs. operational oriented) of the collaborations (Wang et al. 2015; Aarikka-Stenroos et al. 2014; Shan et al. 1994; Bengtsson et al. 2015). We suggest a curvilinear relationship between the scope and the innovation performance. This curvilinear relationship is rooted in a social capital perspective (Molina-Morales and Martinez-Fernandez 2009; Mishra, Chandrasekaran, and MacCormack 2015). Firms that collaborate benefit from an increase in the exchange of information and resources, but after a certain threshold, they incur in higher costs due to ongoing relationship maintenance, time and effort. Consequently, we suggest that:

**Hypothesis 1**: innovation-oriented collaboration is curvilinearly (inverted U-shaped) related to the firm's performance;

**Hypothesis 2:** operational-oriented collaboration is curvilinearly (inverted U-shaped) related to the firm's performance.

*2.2 The moderating role of managerial and internationalization capabilities*

The central argument of this paper is that internal capabilities moderate the collaborations – performance relation. This belief is rooted in the resource-based view of the firm, according to which firms differ in their performance due to their resources and capabilities (Amit and Schoemaker 1993). Usually, extant research has focused on relational capabilities (Fitjar et al., 2013; Walter et al. 2006), defined as "*the ability to integrate a large periphery of heterogeneous weak ties and a core of strong ties*" (Capaldo 2007: 585). These capabilities facilitate learning, share knowledge (Im and Rai 2008), and reduce transaction costs via increasing trust. However, previous studies have not investigated the role of other capabilities in making the collaborations effective. In particular, in this paper we look at two organizational capabilities: the managerial capabilities and the internationalization capability.

Managerial capabilities represent the ability of the firm to manage its financial, human resources and operational activities (Cruz-Ros & Gonzalez-Cruz, 2015; Fitjar et al., 2013; Hooley et al., 2005; Lee et

al., 2001). Managerial capabilities are different from absorptive capacity in that the latter represents prior ability to "recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990:128). In this sense, absorptive capacity refers to the ability to evaluate and utilize outside knowledge, while managerial capabilities look not at the knowledge but at the financial, human and operational activities of the partners. The rationale of considering managerial capabilities as a factor impacting the collaboration-performance relationship lies on two main reasons. First, human resources represent one of the means via which an organization reaches its goals. Being able to manage the human resources is important for extracting value from collaborations. Second, managers should also be expert in dealing with operation and managing financial resources in order to internally exploit the external resources of the collaboration. Managers, in fact, control resources, filter ideas and set strategies (Fitjar et al. 2013; Lee et al., 2001) and managerial capabilities may enhance collaborations via reducing operational costs, reducing business risk exposure, streamlining business processes and capitalizing on market opportunities (Wang et al. 2015). On the basis of the previous considerations, we hypothesised that:

**Hypothesis 3a**: the higher the managerial capabilities of the firm, the more effective the innovation-oriented collaboration will be in influencing firm's performance;

**Hypothesis 3b**: the higher the managerial capabilities of the firm, the more effective the operational-oriented collaboration will be in influencing firm's performance.

An underdeveloped stream of research is instead represented by the capacity of the firm in being international. Firms often collaborate with external partners for entering new markets or reinforcing their presence in existing markets. On the one hand, companies may benefit from having international activities since they may increase market opportunities (Kotabe et al., 2002), fasten new product development and introduction (Bartlett and Goshal 1989). Firms need also to manage international partnerships (Fitjar et al., 2013) and choose among alliances/licensing agreements, the level of integration into customers and supplier channels, among the others (Freeman et al. 2006). However, being international may have also costs that relate mainly to select the proper foreign market entry mode, to choose the markets where to sell products/provide services, to manage the international process. Hence, the capability of managing international activities requires costs in term of transaction, management and coordination (Kotabe et al., 2002) that may hamper the performance of the firm. In particular, Kafouros et al. (2008) find that the internationalization activity needs to be under a certain threshold level in order to benefit from innovation. Firms "*are unable to benefit from innovation if their international activity is below a threshold level*" (Kafouros et al. 2008). The curvilinear relationship the literature finds, may be the result of excessive management costs (Tallman and Li 1996). Consequently, firms that have greater capability in managing their internationalization

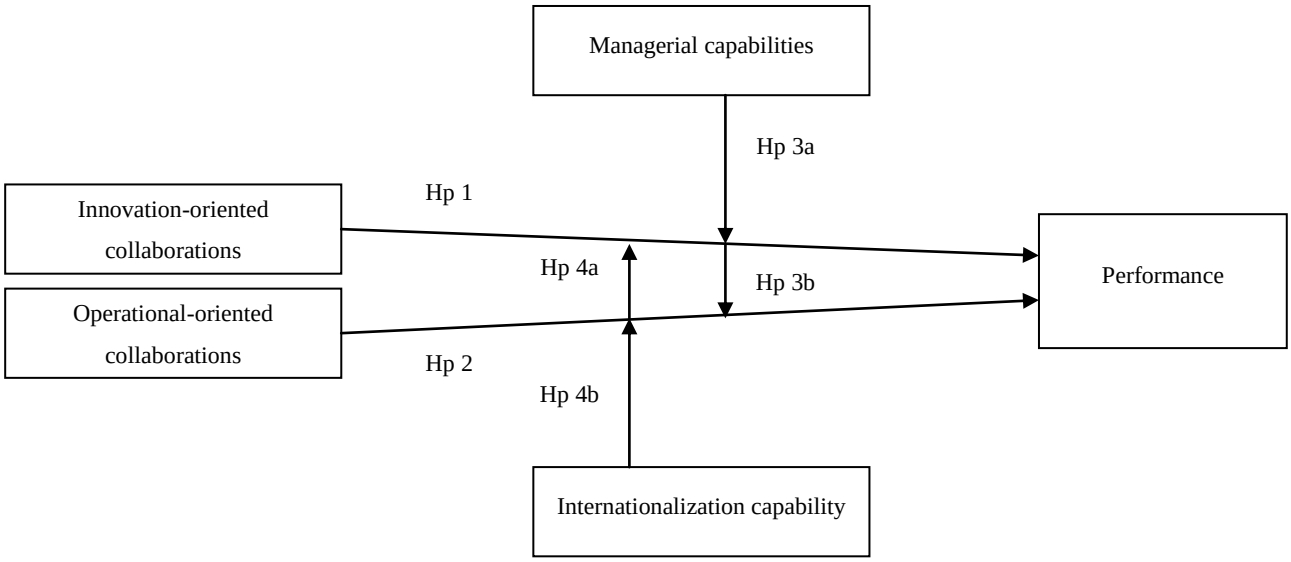
processes, may perform better than companies that are not able to do that. Moreover, the fact that firms are able to compete on international markets may also impact the way firms benefit from their collaborations. Henceforth, we suggest that:

**Hypothesis 4a**: the higher the internationalization capabilities of the firm, the more effective the external innovation-oriented search height will be in influencing firm's performance;

**Hypothesis 4b**: the higher the internationalization capabilities of the firm, the more effective the external operational-oriented search height will be in influencing firm's performance.

Adding to previous research noticing that firms need to possess specific capabilities in managing collaborations (Mitrega et al., 2012), we look at the managerial capabilities and the internationalization capability on the relationship between numbers of innovation-oriented and operational-oriented collaborations and firm's performance (as measured by T2M) in the LS sector. Our theoretical framework is presented in Figure 1.

**Figure 1. The conceptual model**




## 3. METHODOLOGY AND MEASUREMENT

*3.1. Sample and data collection*

We tested our hypotheses by looking at the LS sector, characterized by 3 main industries, namely pharmaceuticals, biotechnology and medical devices, and the emerging segment of cosmeceuticals and nutraceuticals. A fourth segment comprises firms specialized in delivering services to support these industries. The choice of focusing on the LS sector is led by the fact that firms tend to be involved in various kinds of partnerships (Ferreras-Méndez et al., 2015; Liebeskind et al., 1996; Shan et

al., 1994) and external to the firm knowledge sources is increasingly relevant (Belussi et al., 2010) since knowledge base is complex and the sources of expertise widely dispersed (Powell et al., 1996).

We carried out our questionnaire on the firms operating in the LS sector in Tuscany. The Tuscan LS sector is third in Italy for its concentration of pharmaceutical and biotechnological industries (Farmindustria, 2011; AssoBiotech, 2012; Pucci and Zanni, 2012) and was geographically proximate to the research team, thus simplifying control of the consistency and quality of the research data. The list of all firms was built by the research team considering national censuses of professional associations (AssoBiotech, Farmindustria, and AssoBiomedica) and data from the Chamber of Commerce. A final list of 317 for-profit firms was created and that list was updated to December 2012. The firms employed a total of 19,419 people.

The questionnaire was tested with founders and managers belonging to all the segments of LS sector, with two managers of the Tuscan Life Sciences Foundation and two members of the Steering Committee of the Tuscan Regional LS District. Data were collected via email from March to May 2012. A presentation letter with the research objectives and privacy assurance was sent via email to all the 317 firms. Subsequently, the research team verified the information obtained through the questionnaire through secondary sources, namely the Chamber of Commerce for the structural data of the firms and the number of patents in the Qpat database, and, if necessary, carried out follow-up telephone interviews with the person (entrepreneurs, owners or CEOs) who had completed the questionnaire. A total of 151 firms, representing 47.63% of the target population, returned the questionnaires. Table 1 presents the sample.

| Firms of the Tuscan LSs sector | **Population** | | | | **Sampled firms** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Firms** | | **Employees** | | **Firms** | | **Employees** | |
| | **N** | **%** | **N** | **%** | **N** | **%** | **N** | **%** |
| Biotechnology | 36 | 11.36 | 673 | 3.47 | 24 | 15.89 | 487 | 3.56 |
| Pharmaceuticals | 47 | 14.83 | 11919 | 61.37 | 25 | 16.56 | 8297 | 60.58 |
| Medical devices | 116 | 36.59 | 3399 | 17.50 | 48 | 31.79 | 2541 | 18.55 |
| Cosmeceuticals and Nutraceuticals | 28 | 8.83 | 817 | 4.21 | 9 | 5.96 | 691 | 5.04 |
| Others | 90 | 28.39 | 2611 | 13.45 | 45 | 29.80 | 1681 | 12.27 |
| Total | 317 | 100.00 | 19419 | 100.00 | 151 | 100.00 | 13697 | 100.00 |

Redemption: 47.63% (151/317). Our elaboration of Chamber of Commerce data, website and interviews with sector experts

**Table 13. Sectoral classification of LSs firms: universe and sample of firms**

*3.2 Definitions and measurements of the constructs*

***Dependent variable.*** The dependent variable chosen in our study is the elapsed time (months) between the start of the R&D phase and the market launch of the new product (*fR&DtM*) (Griffin

2002). The choice of focusing on T2M rather than on innovation-performance or financial performance has been led by that having a short time to market is an important factor in determining competitive advantage, in particular in industries where R&D is long and complex (Rothaermel and Deeds 2004; Shan et al., 1994) such as LS. Moreover, T2M is the largest industry challenge in sectors such as LS (Prašnikar and Škerlj 2006), characterized by ever-shortening technology development cycles, long product development cycles and short product cycles (Liebeskind et al. 1996).

***Innovation-oriented and operational-oriented collaborations.*** To construct the measurements relative to collaborations for each firm, the questionnaire asked for the name and location of those partners considered strategically relevant to each firm's activity. For each partner the type of activity was requested as well, that is, if it was another firm/private entity, a public research organization (PRO), a public institution (not research) or a scientific park/incubator. Lastly, firms were asked to specify the reason for the collaboration, if it was for operational reasons (supply, distribution, sales) or rather for reasons related to R&D and improvement of innovation.

The total number of innovation-oriented collaborations (Inn_coll) and the total number of operational-oriented collaborations (Op_coll) are counted for each firm and used in the analysis which follows. It is interesting to note that we introduce a third dimension to Laursen & Salter (2006)'s contribution via considering the *height* of external sources, i.e. the number of external search partners, no matter the relative importance (depth) nor the kind of partners (breadth). Hence, not only the type of partners (breadth), whether science- or market-focused innovation partners (Gesing et al. 2015), and the extent to which a firm draw from search channels (depth) matter (Laursen & Salter, 2006), but also the number of collaborations a firm has is important.

***Capabilities.*** The managerial capability construct (*Man. Cap.*), developed by Hooley *et al*. (2005), is measured by three items that evaluate the competences of the firm in managing its financial and human resources as well as its operational activities. The construct has a Cronbach's of 0.89, indicating a high level of reliability (see Appendix A). Furthermore, total correlations vary from 0.72 to 0.74, thus all above the threshold of 0.45 suggested in the literature (Parker *et* al., 1997). The evidence furnished by the validity and reliability measurements allows us to use the average score of the items in the analysis which follows. The ratio of foreign sales on total sales is used as proxy of the internationalization capacity of the firm (*Internat. Cap.*) (Tallman and Li 1996; Pucci et al., 2016).

***Control variables.*** Therefore, during the tests conducted to verify the relationships hypothesized, some control variables were introduced which could have an influence on the time to market of the firm. The dimensions of firms (*Size*) were measured as logarithms of the number of employees. The age (*Age*) of the firm was measured by the logarithms of the number of years passed since the firm was founded. The segment a firm belonged to was controlled by introducing three dummy variables

for the pharmaceutical (*Pharma*), biotechnological (*Biotech*) and medical devices (*Med. Dev.*) segments. *R&D Exp.* is the logarithm of the expenditures in research and development (Belussi et al., 2010).

Table 2 furnishes the descriptive statistics and the correlations among all the variables used in the study. Appendix B reports the VIF scores and the tolerances of the explanatory variables for the model. These values (compared as well to the correlation values of Table 2) do not indicate significant issues of multicollinearity among variables.

| Variables | | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] | [11] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [1] | fR&DtM | 1.000 | | | | | | | | | | |
| [2] | Size (log) | -0.175 | 1.000 | | | | | | | | | |
| [3] | Age (log) | -0.067 | 0.588 | 1.000 | | | | | | | | |
| [4] | Pharma | 0.040 | 0.305 | 0.187 | 1.000 | | | | | | | |
| [5] | Biotech | -0.060 | -0.099 | -0.252 | -0.194 | 1.000 | | | | | | |
| [6] | Med. Dev. | -0.003 | 0.069 | 0.107 | 0.304 | -0.297 | 1.000 | | | | | |
| [7] | R&D Exp. (log) | -0.282 | 0.609 | 0.427 | 0.117 | 0.033 | -0.134 | 1.000 | | | | |
| [8] | Op_coll | -0.304 | 0.532 | 0.222 | 0.073 | 0.031 | -0.067 | 0.329 | 1.000 | | | |
| [9] | Inn_coll | -0.351 | 0.558 | 0.190 | 0.190 | 0.122 | -0.057 | 0.344 | 0.557 | 1.000 | | |
| [10] | Internat. Cap. | -0.110 | 0.198 | 0.159 | 0.027 | 0.202 | 0.008 | 0.240 | 0.129 | 0.284 | 1.000 | |
| [11] | Man. Cap. | -0.131 | 0.525 | 0.322 | 0.163 | -0.104 | -0.071 | 0.202 | 0.361 | 0.285 | 0.033 | 1.000 |
| | Mean | 43.139 | 2.419 | 2.382 | 0.166 | 0.159 | 0.318 | 9.671 | 3.417 | 2.861 | 0.183 | 4.446 |
| | St. Dev. | 24.166 | 1.806 | 1.071 | 0.373 | 0.367 | 0.467 | 4.858 | 2.356 | 2.580 | 0.286 | 1.225 |
| | Min | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Max | 120 | 7.869 | 4.673 | 1 | 1 | 1 | 18.642 | 14 | 18 | 1 | 7 |

Note: N = 151. Correlation coefficients greater than 0.163 in absolute value are statistically significant at 95%.

**Table 14. Descriptive statistics and correlations**

## 4. ANALYSIS AND RESULTS

In order to investigate the relation between collaborations and T2M as moderated by firm's capabilities we utilize hierarchical multiple and moderated hierarchical multiple regressions (Cohen and Cohen, 1983). Before analysing the data, it is important to note that due to the specific nature of the dependent variable (T2M), the lower is the dependent variable, the higher the firm's performance. Henceforth, the inverted U-shape relationship as hypothesized in Hypotheses 1-4 is here reversed in a

U-shape relationship. Table 3 reports the results of the analysis. In the first model (Model A) the control variables were entered. In the second model (Model B) the main effects were entered. In the models C moderator effects (capabilities) were entered. Models D, E and F test for a curvilinear U-shaped effect of R&D expenditures, operational-oriented and innovation-oriented collaborations on T2M respectively. In models from G to L interactions terms were entered.

The results show that both innovative-oriented and operational-oriented collaborations have a negative impact on T2M: increasing the number of collaborations the company has with external partners reduces the number of months between the start of the R&D phase and the launch of a new product in the market (model B), thus improving the firm's performance. However, there is a U-shaped curvilinear effect on the T2M of the firm as showed in models D-F. Beyond a certain threshold, increasing the R&D expenditures as well as the number of relationships (innovative and operational) increases the time to market.

Managerial and internationalization capabilities do not have a direct impact on T2M (model C) but they are positive moderators of the collaboration-T2M relationship (models I-L). Figures 2 and 3 show this moderator effect. Beyond a certain threshold of complexity generated by the number of collaborations (both innovative and operational) management and internationalization capabilities play a decisive role in reducing the time of research, development and marketing of the new product.

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| Variables | Mod. A | Mod. B | Mod. C | Mod. D | Mod. E | Mod. F | Mod. G | Mod. H | Mod. I | Mod. J | Mod. K | Mod. L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size (log) | -0.874 | 3.308* | 3.944** | 2.720 | 5.402*** | 4.238** | 4.174** | 5.066*** | 4.211** | 4.564** | 4.076** | 5.138*** |
| | (1.582) | (1.779) | (1.912) | (2.009) | (1.905) | (1.802) | (1.816) | (1.890) | (1.858) | (1.911) | (1.857) | (1.869) |
| Age (log) | 1.469 | -0.257 | -0.219 | -1.181 | 0.061 | 0.206 | 0.274 | 0.294 | 0.383 | 0.395 | 0.048 | -0.168 |
| | (2.308) | (2.217) | (2.245) | (2.226) | (2.175) | (2.117) | (2.135) | (2.185) | (2.187) | (2.237) | (2.181) | (2.158) |
| Pharma | 5.698 | 6.337 | 6.249 | 6.784 | 5.041 | 6.251 | 6.436 | 4.558 | 5.387 | 5.055 | 6.735 | 5.340 |
| | (5.912) | (5.674) | (5.699) | (5.658) | (5.528) | (5.367) | (5.410) | (5.556) | (5.537) | (5.658) | (5.534) | (5.485) |
| Biotech | -1.942 | 2.272 | 1.816 | 3.346 | 4.447 | 5.168 | 5.751 | 4.520 | 5.805 | 4.376 | 3.252 | 4.306 |
| | (5.915) | (5.714) | (5.874) | (5.883) | (5.743) | (5.586) | (5.661) | (5.766) | (5.843) | (5.929) | (5.721) | (5.691) |
| Med. Dev. | 2.187 | 3.323 | 3.189 | 3.181 | 0.499 | 1.067 | 1.209 | 0.703 | 1.918 | 2.158 | 2.245 | 0.790 |
| | (4.809) | (4.579) | (4.603) | (4.564) | (4.532) | (4.363) | (4.397) | (4.537) | (4.486) | (4.574) | (4.479) | (4.477) |
| R&D Exp. (log) | -1.426*** | -1.405*** | -1.489*** | -3.963*** | -1.659*** | -1.343*** | -1.602*** | -1.870*** | -1.533*** | -1.656*** | -1.403*** | -1.528*** |
| | (0.516) | (0.488) | (0.500) | (1.432) | (0.487) | (0.472) | (0.476) | (0.501) | (0.486) | (0.500) | (0.486) | (0.481) |
| Op_coll | | -1.712* | -1.586 | -2.165** | -8.042*** | -2.517** | -2.595*** | -4.843*** | -2.109** | -2.833** | -1.991** | -4.186*** |
| | | (0.990) | (1.004) | (1.043) | (2.221) | (0.969) | (0.985) | (1.429) | (0.988) | (1.154) | (0.983) | (1.214) |
| Inn_coll | | -2.961*** | -3.018*** | -3.532*** | -3.964*** | -9.072*** | -6.567*** | -4.035*** | -4.808*** | -3.743*** | -4.977*** | -3.958*** |
| | | (0.949) | (0.972) | (1.003) | (0.985) | (1.667) | (1.274) | (0.998) | (1.105) | (1.020) | (1.136) | (0.972) |
| Internat. Cap. | | | 0.892 | 0.193 | -0.939 | -0.263 | -0.030 | -0.337 | -0.069 | 1.027 | -7.677 | -11.098*** |
| | | | (6.945) | (6.897) | (6.745) | (6.545) | (6.597) | (6.750) | (6.743) | (6.861) | (7.289) | (7.490) |
| Manag. Cap. | | | -1.647 | -1.988 | -2.545 | -2.102 | -2.363 | -2.550 | -3.427* | -4.025* | -1.963 | -1.757 |
| | | | (1.795) | (1.790) | (1.760) | (1.694) | (1.713) | (1.766) | (1.834) | (2.101) | (1.746) | (1.726) |
| R&D Exp.$^2$ | | | | 0.208* | | | | | | | | |
| | | | | (0.113) | | | | | | | | |
| Op_coll$^2$ | | | | | 0.601*** | | | | | | | |
| | | | | | (0.186) | | | | | | | |
| Inn_coll$^2$ | | | | | | 0.534*** | | | | | | |
| | | | | | | (0.123) | | | | | | |
| Inn_coll.$^2$ X R&D Exp.$^2$ | | | | | | | 0.001*** | | | | | |
| | | | | | | | (0.000) | | | | | |
| Op_coll.$^2$ X R&D Exp.$^2$ | | | | | | | | 0.001*** | | | | |
| | | | | | | | | (0.000) | | | | |
| Inn_coll.$^2$ X Man. Cap. | | | | | | | | | 0.109*** | | | |
| | | | | | | | | | (0.035) | | | |
| Op_coll$^2$ X Man. Cap. | | | | | | | | | | 0.113** | | |
| | | | | | | | | | | (0.054) | | |
| Inn_coll$^2$ X Inter. Cap. | | | | | | | | | | | 0.407*** | |
| | | | | | | | | | | | (0.132) | |
| Op_coll$^2$ X Inter. Cap. | | | | | | | | | | | | 0.658*** |
| | | | | | | | | | | | | (0.186) |
| Constant | 54.215*** | 61.193*** | 67.401** | 74.666*** | 84.248*** | 79.234*** | 79.842*** | 82.024*** | 79.331*** | 81.655*** | 73.490*** | 76.645*** |
| | (5.768) | (5.803) | (8.879) | (9.647) | (10.050) | (8.795) | (8.974) | (9.812) | (9.432) | (11.070) | (8.841) | (8.928) |
| *$R^2$* | *0.093* | *0.201* | *0.206* | *0.224* | *0.261* | *0.300* | *0.289* | *0.257* | *0.257* | *0.230* | *0.257* | *0.271* |
| *Adj. $R^2$* | *0.055* | *0.156* | *0.149* | *0.163* | *0.203* | *0.245* | *0.233* | *0.199* | *0.198* | *0.169* | *0.198* | *0.213* |
| *Incr. F test* | | *9.56**** | *0.44* | *3.39** | *10.45**** | *18.86**** | *16.34**** | *9.70**** | *9.67**** | *4.45*** | *9.57**** | *12.47**** |

*Note: N = 151; Standard errors in parentheses. * p < 0.1, ** p < 0.5, *** p < 0.01*

**Table 15. Model Comparison Results of Hierarchical Multiple Regression Analysis**

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**Figure2. Slope Analysis for the effect of Managerial Capabilities on Innovation Relationships/Operational Relationships – "from R&D to Market" time (95% CI)**

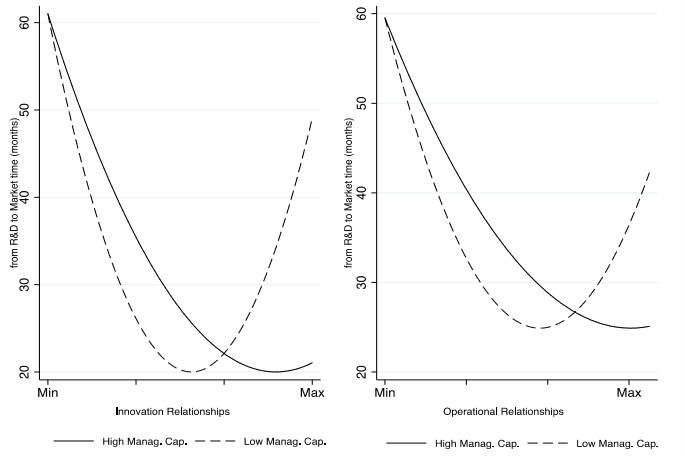
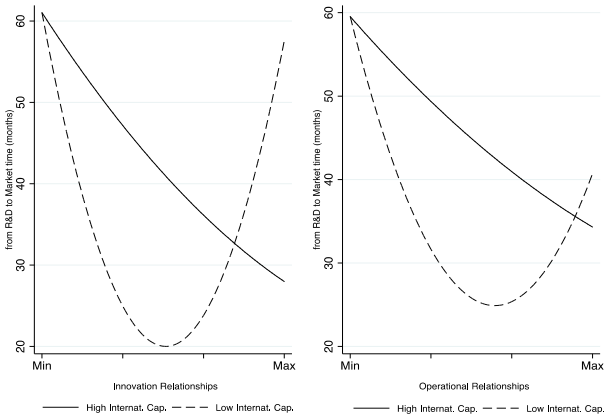



**Figure 3. Slope Analysis for the effect of Internationalization capability on Innovation Relationships/Operational Relationships – "from R&D to Market" time (95% CI)**




## 5. CONCLUSIONS AND IMPLICATIONS

Firms increasingly use their networks in order to get access to missing resources and improving their performance (Pittaway et al., 2004). In deepening this stream of research, however, OI scholars have noticed that collaborations are not always positive (Laursen and Salter 2006) and that their impact on the firm's performance may be moderated by the firm's capabilities (Järvensivu & Möller, 2009; Lee et al., 2001; Mitrega et al., 2012). These studies have mainly looked at capabilities needed to manage the network of relationships such as the relational capabilities (Mitrega et al. 2012), thus overlooking at other types of capabilities that may affect the collaboration-performance relationship. Moreover, research on collaborations has not distinguished the heterogeneity of the scope of collaborations,

considering them as a one-fits-all concept whose variety is given only by the types of partners or the intensity of relationships.

The present study enhances our understanding in two ways: distinguishing between two types of collaborations based on their scope (Aarikka-Stenroos et al., 2014; Shan et al., 1994; Bengtsson et al. 2015) and introducing and investigating the role of two types of capabilities, namely the managerial capabilities and the internationalization capability. Our results show that collaborations are important for reducing T2M, but up to a certain point. The quadratic effects that we found for both innovation-oriented and operation-oriented collaborations show that the effect of partners on T2M is positive up to a certain level. After that threshold, the impact of collaborations on T2M reverses. The fact that T2M increases when the number of collaborations increases too much stresses that managing collaborations becomes difficult after a certain level. Henceforth, firms should develop specific capabilities in order to mitigate this effect. From a practical perspective this study suggests that to fasten T2M in LS sector firms should be able to manage the number of collaborations they have and that those firms with lower levels of managerial and internationalization capabilities benefits more from increasing the number of collaborations than those with higher managerial and internationalization capabilities, at least up to a certain number of collaborations.

This paper presents some limitations that could be solved by future research. A first limitation is inherent to the usual problem of survey research: although the controls did not indicate significant problems of common method variance, its potential influence cannot be completely excluded in a self-report research study (Podsakoff *et al*., 2003; Podsakoff and Organ, 1986) as regards the constructs for the capabilities within the firms. Secondly, the cross-sectional nature of the research could be a potential source of criticism, and future studies could employ a longitudinal research design to examine the dynamics and timing of the examined relationships. Lastly, the work is entirely based on the evidence from a particular regional network. Henceforth, a national or international comparison among LS networks at the same developmental level would help to further validate the results.

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## APPENDIX A: MANAGERIAL CAPABILITIES: MEASUREMENT ITEMS AND VALIDITY ASSESSMENT (N = 151)

| **Measure** | **Item description** [a] | **Factor Loading** |
|---|---|---|
| Managerial capabilities<br>$\alpha$ = .89 - AVE = .71<br>(Hooley *et al.*, 2005) | *To what extent do the following statements apply to your organization?*<br>1. Strong financial management capabilities<br>2. Effective human resource management<br>3. Good operations management expertise | .83 - .85 |

a Seven-point scale anchored at 1 = not at all and 7 = to an extreme extent.

*Appendix B: VIF scores and tolerances among study variables –*

| Variables | VIF scores | Tolerance |
|---|---|---|
| R&D Exp. (log) | 1.21 | 0.82 |
| Op. relation. | 1.59 | 0.64 |
| Inn. Relation | 1.61 | 0.63 |
| Internat. Cap. | 1.12 | 0.89 |
| Managerial Capabilities | 1.17 | 0.85 |

Mean VIF: 1.34. Condition number: 11.896

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